AT THE TOP OF EACH PAGE write (1) your name and (2) your section number in the space provided. Textbooks, class notes and electronic devices of any kind are NOT permitted. Do all your work on this exam. Fully simplify all solutions. For problems #2 - #6 you must show a complete and valid solution method for full credit.

1. (25 points total) These problems will be graded on your answer only, no partial credit. Find the exact value of the expression, if it is defined.

(a) \( \tan \frac{5\pi}{4} = \) ____________
(b) \( \cos \frac{2\pi}{3} = \) ____________
(c) \( \sec 270^\circ = \) ____________
(d) \( \sin(-135^\circ) = \) ____________
(e) \( \cos^{-1}\left(-\frac{\sqrt{3}}{2}\right) = \) ____________
(f) \( \tan^{-1}(-\sqrt{3}) = \) ____________
(g) \( \sin^{-1}\left(\sin\frac{7\pi}{6}\right) = \) ____________
(h) \( \tan\left(\sin^{-1}\frac{2}{5}\right) = \) ____________

2. (10 points) (a) A circular arc of length 100 feet subtends a central angle of 45°. Find the radius of the circle.

Answer: (a) ________________

(b) A cyclist is riding a bicycle whose wheels have a diameter 24 inches. Suppose the wheels turn at a rate of 30 revolutions per minute. Find the speed of the cyclist in feet per minute.

Answer: (b) ________________
3. (20 points total) Graph **TWO COMPLETE PERIODS** of each function. Fill in the specified information for each function, including the \(x\)-locations of two zeros and two asymptotes as requested. Be sure to clearly indicate your scale on the \(x\)-axis.

(a) Graph the function \(f(x) = 3\cos\left(\frac{1}{2}x - \pi\right) = 3\cos\frac{1}{2}(x-2\pi)\).

- **Amplitude** \(3\)
- **Period** \(4\pi\)
- **Phase Shift** \(2\pi\)
- **Location of two zeros** \(3\pi, 5\pi\)

(b) Graph the function \(g(x) = \tan(2x + \pi)\).

- **Period** \(\pi/2\)
- **Phase Shift** \(-\pi/2\)
- **Location of two zeros** \(-\pi/2, 0\)
- **Location of two asymptotes (if any)** \(-3\pi/4, -\pi/4\)
4. (15 points) We are installing a tram to the top of a mountain. The bottom of the tram will be 3 kilometers from the base of the mountain. The mountainside is 4 kilometers from the base to the top. If the mountainside forms a 60° angle with the horizontal, how long must the tram cable be?

\[
c^2 = a^2 + b^2 - 2ab \cos 120^\circ
\]

\[
= 9 + 16 - 24 \left(-\frac{1}{2}\right)
\]

\[
= 25 + 12
\]

\[
= 37 \Rightarrow c = \sqrt{37}
\]

Answer: \(\sqrt{37}\)

[Diagram showing the application of the Law of Cosines and an alternative method]
5. (20 points) Consider the diagram of a new jet-powered drone shown below. The leading edge of one wing indicated by line segment CW is 20 feet long. The angle ACW of the leading edge is 150°. The fuselage, length EE', is 3 feet across. The trailing edge indicated by line segment WE is $10\sqrt{2}$ feet.

(a) The wingspan of an aircraft is measured from one wing tip to the other. What is the wingspan WW' of the drone?

\[ h = 20 \sin 30^\circ = 10 \]

Wingspan = 10 + 3 + 10

Answer: (a) \(23^1\)

(b) The triangle CWE forms one wing of the drone. What is the area of one wing?

\[
A = \frac{1}{2} \cdot 20 \cdot 10 \cdot \sin 30^\circ = \frac{1}{2} (20)(10+10\sqrt{3}) \cdot \frac{\sin 30^\circ}{\sqrt{2}}
\]

\[ A = \frac{1}{2} (10\sqrt{3} + 10)(10) \]

Answer: (b) \(50\sqrt{3} + 50\)
At supersonic speeds a compression wave called a Mach wave will form off the tip of the nose at an angle $\mu$ with the direction of airflow according to the equation

$$\mu = \sin^{-1}\left(\frac{1}{M}\right)$$

where $M$ is the Mach number.

(a) Find the angle of the Mach wave in degrees that forms when the drone is traveling at Mach 2 ($M = 2$).

$$\mu = \sin^{-1}\left(\frac{1}{2}\right)$$

$$= 30^\circ$$

Answer: (a) $30^\circ$

(b) At what Mach number will the Mach wave be perpendicular to the direction of airflow?

$$90^\circ = \sin^{-1}\left(\frac{1}{M}\right)$$

$$\frac{1}{M} = \sin 90^\circ = 1$$

$$M = 1$$

Answer: (b) $M = 1$